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Canada Centre for Mineral and Energy Technology | Centre canadien de la technologie des minéraux et de l'énergie

CSA COMPARATIVE SAMPLE PROGRAM - SAMPLE NO. 42 - TEST RESULTS

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Project: 30.37.01
Performance of Concrete Incorporating Supplementary Cementing Materials

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CSA CEMENT TESTING PROGRAMME*
Sample No. 42

The attached tables represent the results obtained from sample No. 42 of the Co-operative Cement Sample Comparative Programme in compliance with the CSA Committee on Hydraulic Cements. These results were obtained and reported by the participating laboratories with CANMET acting as the coordinator for this round-robin testing program.

Recalling that the cement prepared for the two previous samples No. 40 and 41 were notably different from cement samples distributed earlier in this program i.e. a Type 20 cement was prepared from a larger stock which is now serving as a National Reference Sample. The analysis of these samples, No's 40 and 41, particularly the strength data, were used to characterize this National Reference Sample.

For sample No. 42, the cement distributed was a Normal Portland Cement, Type 10, blended and prepared in our CANMET laboratory from a 360 kg cement stock supplied by one of the cement distributators participating in this program.

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* Results were compiled and analyzed by K.E. Painter, Concrete Technology Section, MSL, CANMET

Sample No. 42

Summary of Statistical Analysis of Test Results - Chemical Analysis

Description of Tests	N*	Statistical Analysis of all Data Reported					
		Maximum	Minimum	Average	Range	Standard Deviation	Coefficient of Variation, %
Chemical Analysis (CSA Tests)							
Loss on ignition, %	19	2.67	2.37	2.48	0.3	0.08	3.23
Insoluble residue, %	16	1.00	0.42	0.75	0.58	0.15	19.95
Sulphur trioxide, %	19	2.30	2.07	2.19	0.23	0.06	2.75
Magnesia, %	18	3.30	2.51	2.97	0.79	0.17	5.70
Ferric Oxide, %	19	2.21	1.89	2.03	0.32	0.08	3.70
Alumina, %	18	4.93	4.20	4.48	0.73	0.16	3.60
Tricalcium Aluminate, %	18	9.60	7.78	8.46	1.82	0.40	5.00
Chemical Analysis (Additional Tests)							
Silicon Dioxide, %	19	21.84	21.11	21.56	0.73	0.19	0.85
Calcium Oxide (Total), %	19	63.53	62.18	63.03	1.35	0.38	0.60
Calcium Oxide (Free), %	17	1.41	0.88	1.06	0.53	0.12	11.30
Sodium Oxide, %	18	0.37	0.17	0.31	0.20	0.05	17.25
Potassium Oxide, %	19	0.67	0.56	0.61	0.11	0.03	5.55
Manganic Oxide, %	8	0.10	0.03	0.06	0.07	0.03	41.65
Titanium Oxide, %	14	0.41	0.15	0.19	0.26	0.06	33.0
Phosphorus Pentoxide, %	12	0.33	0.12	0.16	0.21	0.06	36.0
Strontium Oxide, %	12	0.43	0.20	0.38	0.23	0.08	21.85
Lead Oxide, %							
Zinc Oxide, %	5	0.02	0.01	0.01	-	0.01	27.25
Copper Oxide, %							
Chloride, %							
Fluoride, %							

*N - Number of laboratories reporting

Sample No. 42

Summary of Statistical Analysis of Test Results - Physical Tests

Description of Tests	N**	Statistical Analysis of all Data Reported					
		Maximum	Minimum	Average	Range	Standard Deviation	Coefficient of Variation, %
Physical Tests - General							
Fineness							
- Passing 45 µm, %							
1 gram sample	19	89.5	84.9	88.0	4.6	1.07	1.20
- Blaine, m^2/kg	19	328	305	319	23	6.21	1.95
Soundness							
- Autoclave Expansion, %	17	0.15	0.05	0.11	0.10	0.03	23.90
Normal Consistency							
- w/c, %	19	25.4	23.6	24.4	1.8	0.51	2.10
Setting Time, min.	19	205	110	177	95	22.65	12.80
Sulphate Expansion, %	15	0.074	0.001	0.014	0.073	0.02	142.85
False Set							
- Penetration							
Final/Initial, %	18	100.	71.4	82.7	28.6	6.28	7.59
Physical Tests - Mortor Strength*							
Compressive Strength, MPa							
3-day	19	22.6	16.3	19.5	6.3	1.37	7.05
7-day	19	30.5	22.4	26.8	8.1	1.89	7.05
28-day	19	39.4	30.6	36.3	8.8	2.06	5.70
Flow, %	19	130	108	119	22	6.25	5.25

*Uncorrected values only.

**N - Number of laboratories reporting.

Sample No. 42

Chemical Analysis - CSA Tests

Participant	L.O.I. %	Insoluble %	SO_3, %	MgO, %	Fe_2O_3 %	Al_2O_3, %	C_3A, %
A							
B	2.43	0.73	2.13	2.83	1.98	4.20	7.78
C	2.41	0.42	2.23	3.06	2.02	4.49	8.48
D	2.39	0.78	2.12	2.98	2.05	4.36	8.09
E	2.45	-	2.20	2.89	2.01	4.56	8.69
F	2.41	0.81	2.25	2.97	2.00	4.28	7.96
G	2.46	0.78	2.20	2.84	1.99	4.55	8.69
	2.52	0.81	2.19	2.51	2.03	4.51	8.52
L							
M							
N	2.67	-	2.24	3.10	2.04	4.55	8.61
O							
Q	2.37	0.81	2.25	2.93	2.01	4.50	8.53
S							
T							
V	2.50	0.50	2.30	3.30	2.10	4.45	8.24
W	2.46	0.80	2.13	2.97	2.05	4.93	9.60
X	2.61	0.58	2.19	2.89	2.20	-	-
Y							
Z	2.45	0.64	2.07	2.82	2.21	4.54	8.30
AA	2.40	0.82	2.16	3.03	1.96	4.36	8.24
BB	2.54	-	2.24	3.13	2.07	4.31	7.92
CC	2.40	1.00	2.27	3.00	2.04	4.62	8.80
DD							
EE	2.54	0.92	2.12	-	2.01	4.58	8.74
FF	2.54	0.83	2.16	3.12	1.89	4.53	8.81
HH							
JJ							
KK							
VV	2.52	0.71	2.19	3.00	1.98	4.40	8.31

Sample No. 42

Chemical Analysis - Additional Tests

Participant	Chemical Analysis													
	SiO_2, %	CAO Total %	CAO (Free) %	Na_2O %	K_2O %	Mn_2O_3, %	TiO_2, %	P_2O_5, %	SrO, %	PbO, %	ZnO %	CuO %	Cl^-, %	F^-, %
A														
B	21.70	63.45	1.41	0.30	0.57									
C	21.58	62.82	0.92	0.37	0.62	0.03	0.18	0.15	0.42	-	0.01	-	0.006	0.09
D	21.59	62.18	0.88	0.22	0.63	-	0.18							
E	21.52	62.74	1.14	0.17	0.59									
F	21.76	62.45	-	0.34	0.63	0.06	0.18	0.14	0.40	-	0.01			
G	21.70	63.21	0.93	0.30	0.57	0.10	0.17	0.15	0.20	0.00	0.014	0.003	0.003	0.09
	21.84	63.23	0.98	0.31	0.58	0.102	0.17	0.15	0.21	-	0.015	0.003	0.003	0.09
L													-	
M														
N	21.61	63.35	0.98	0.32	0.65	-	0.17	0.13	0.43					
O														
Q	21.56	62.69	1.08	0.33	0.60	0.05	0.18	0.13	0.38					
S														
T														
V	21.77	63.30	1.08	0.32	0.65	0.05	0.18	0.14	0.43	0.009	0.008	0.003	0.006	
W	21.11	63.53	1.04	0.34	0.60									
X	21.49	63.42	1.01	0.29	0.67	-	0.20	0.14	0.43					
Y														
Z	21.40	63.32	1.15	0.32	0.58									
AA	21.64	63.09	1.05	0.35	0.67	0.06	0.19	0.15	0.42	-	-	-	0.005	
BB	21.41	63.19	1.08	0.34	0.62	-	0.16	0.14	0.42					
CC	21.53	62.81	1.09	-	0.64	-	0.15	0.33	0.42					
DD														
EE	21.35	62.64	1.13	0.22	0.59									
FF	21.80	63.30	-	0.32	0.56	-	0.41							
HH														
JJ														
KK														
VV	21.32	62.79	1.00	0.36	0.61	0.06	0.19	0.12	0.41					

Sample No. 42

Physical Tests - General

Participant	Fineness		Soundness			
	45 μm Sieve % Passing	Blaine m^2/Kg	Autoclave Expansion %	Normal Consistency, W/C %	Setting Time min.	Sulphate Expansion %
	lgm					
A						
B	88.3	313	0.11	24	165	0.007
C	84.9	323	0.10	23.6	170	0
D	87.8	326	0.12	25.2	200	-
E	88.3	321	0.12	25.4	110	0.003
F	87.6	319	0.10	24.3	180	0.008
G	89.5	318	0.12	24.6	190	0.006
J						
K						
L	87.2	328	0.12	24.6	205	0.028
M						
N	89.1	313	0.15	24.0	180	0.005
O						
Q	88.7	322	0.12	24.5	195	0.002
S						
T						
V	86.8	320	0.10	25.2	140	0.004
W	86.6	312	0.12	24.3	180	0.003
X	88.9	328	0.12	24.0	187	0.001
Y						
Z	88.7	321	0.05	24.0	200	0.003
AA	88.1	320	0.14	24.6	192	0.074
BB	88.1	305		24.5	180	0.014
CC	88.6	317	-	25.1	155	-
DD						
EE	88.2	310	0.06	24.6	175	0.016
FF	88.7	316	0.12	23.8	178	0.040
HH						
JJ						
KK						
VV	87.5	325	0.15	24.0	175	-

Physical Tests - CSA Tests

Sample No. 42

Participant	Initial Consist. (ml)	False Set		Mortar Strength				
		Penetration 1 mm		Final/Initial Penetration (%)	Flow %	Compressive Strength, MPa		
		Initial	Final			Uncorrected		
						3-Day	7-Day	28-Day
A								
B	128	36	29	81.0	123	18.5	25.6	34.5
C	126	29	23	79.3	123	20.4	28.5	37.8
D	132	31	23	74.2	108	16.3	22.4	30.6
E	132	34	30	89.0	122	19.0	27.1	37.9
F	130	32	26	81.2	125	20.8	29.2	39.4
G	130	36	30	83.0	116	20.2	27.5	36.2
J								
K								
L	129	31	26	81.8	118	20.6	30.5	37.8
M								
N	130	30	30	100.0	120	19.9	26.5	36.6
O								
Q	131	33	27.5	83.3	112	20.4	26.0	34.6
S								
T								
V	130	28	20	71.4	108	17.9	25.7	35.0
W	130	35	30	85.7	114	20.2	26.6	36.9
X	130	34	31	91.2	126	20.2	25.5	35.7
Y								
Z	128	24	29	83.0	116	19.7	27.7	38.2
AA	130	30	25	83.0	121	19.5	27.6	36.9
BB	128.5	31	24	77.4	113	22.6	29.6	38.8
CC					127	18.3	25.5	36.5
DD								
EE	130	36	30	83.3	115	19.8	26.8	36.4
FF	130	35	29	82.9	118	18.9	25.5	35.6
HH								
JJ								
KK								
VV	128	33	26	78.8	130	18.0	24.7	33.5